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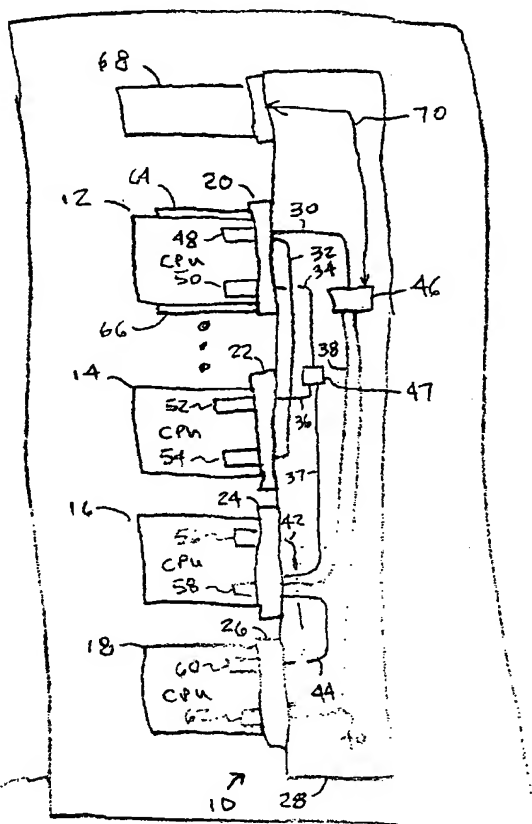
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[Continued on next page]

(54) Title: **DYNAMICALLY CONFIGURABLE BACKPLANE**



(57) Abstract: A method and apparatus are provided for transporting a plurality of information signals among a plurality of signal processing boards (12, 14, 16, 18) all located within a single cabinet (19) of an information processing system. The method includes the steps of connecting a plurality of multi-mode fibers (30, 32, 34, 36, 37, 38, 40, 42, 44) among the plurality of signal processing boards (12, 14, 16, 18) and electronically converting an information signal of the plurality of transported information signals between an electrical format used on a corresponding pair of signal processing boards (12, 14, 16, 18) of the plurality of signal processing boards and an optical format used for transmission through a corresponding multi-mode fiber of the plurality of multi-mode fibers. The method further includes the step of optically switching a transported information signal of the transported information signals between a set of multi-mode fibers of the plurality of multi-mode fibers.

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DYNAMICALLY CONFIGURABLE BACKPLANE

Field of the Invention

5 The field of the invention relates to computers and more particularly to signal processing systems.

Background of the Invention

 Signal processing systems are generally known.
10 Typically, such systems are designed for some particular signal processing, switching or routing goal (e.g., Carrier class routers which direct internet protocol traffic, Enterprise switches which manage corporate Ethernet traffic, Dense Wavelength Division Multiplexing
15 transmission equipment which transmit telephony and data-traffic over optical fibers.) Often such systems are designed by first defining a set of inputs and outputs. Inputs and outputs may be categorized according to processing requirements. Often some
20 inputs/outputs have special processing requirements (e.g., Fourier analysis of spectral components for speech recognition, categorization of trends, etc.).

 To achieve overall processing goals, a number of different signal processing engines must be designed or
25 purchased. Often the individual processing engines are specified as discrete devices to take advantage of commercially available processing boards.

 While such commercially available devices are effective, they often have input/output requirements
30 which can overwhelm most backplane systems. Accordingly, a need exists for a communications system which is capable of operating in a high-speed environment, but which is capable of reconfiguration where necessary.

Brief Description of the Drawings

FIG. 1 depicts an optical communication system in accordance with an illustrated embodiment of the invention;

FIG. 2 depicts a blind-mate connector assembly used by the system of FIG. 1;

FIG. 3 depicts an alternate embodiment of the optical communication system of FIG. 1 using optical splitters and switches;

FIG. 4 depicts another alternate embodiment of the optical communication system of FIG. 1 using a switching format;

FIG. 5 depicts an alternate embodiment of the optical communication system of FIG. 1 using WDM.

Summary

A method and apparatus are provided for transporting a plurality of information signals among a plurality of signal processing boards all located within a single cabinet of an information processing system. The method includes the steps of connecting a plurality of multi-mode fibers among the plurality of signal processing boards and electrooptically converting an information signal of the plurality of transported information signals between an electrical format used on a corresponding pair of signal processing boards of the plurality of signal processing boards and an optical format used for transmission through a corresponding multi-mode fiber of the plurality of multi-mode fibers.

The method further includes the step of optically switching a transported information signal of the transported information signals between a set of multi-mode fibers of the plurality of multi-mode fibers.

Detailed Description of a Preferred Embodiment

FIG. 1 is a block diagram of an optical
5 communication system 10, shown generally in a context of
use, for transporting information signals among
information processing boards. Such system 10 may have
great utility wherever information must be processed and
wherever the processing requirements include a multitude
10 of separate signal processing boards 12, 14, 16, 18, all
located within a single common cabinet or enclosure 19
or within one or more closely spaced enclosures.

As shown, the signal processing boards 12, 14, 16,
18 may be connected by one or more multi-mode optical
15 fibers 30, 32, 34, 36, 37, 38, 40, 42, 44. One or more
optical switches 46 may be provided to dynamically
modify the routing of information signals within the
system 10. Splitters 47 may also be used where signals
must be delivered to a multitude of destinations.

20 The signal processing boards 12, 14, 16, 18 may be
coupled to the optical communication system 10 using one
or more stationary blind-mate connectors 20, 22, 24, 26,
and blind-mate connector modules 48, 50, 52, 54, 56, 58,
60, 62. The stationary blind-mate connectors 20, 22,
25 24, 26 and blind-mate connector modules 48, 50, 52, 54,
56, 58, 60, 62 provide an interface through which
signals generated or used on the signal processing
boards 12, 14, 16, 18 may be coupled one-to-another
through the optical communication system 10.

30 As used herein the blind-mate connector modules 48,
50, 52, 54, 56, 58, 60, 62 may function simply as
alignment devices between the multi-mode fibers of each
of the signal processing boards and corresponding mating
multi-mode fibers of the stationary blind-mate

connectors 20, 22, 24, 26 of the communication system 10. Alternatively, the blind-mate connector modules 48, 50, 52, 54, 56, 58, 60, 62 may also provide the additional function of performing electrooptic
5 conversion between signals processed under an electric format within the signal processing boards 12, 14, 16, 18 and signals transported under an optical format within the communication system 10.

As used herein the term "blind-mate connector"
10 means a connector which relies on a combination of alignment mechanisms to achieve a final alignment between its connected elements. For example, FIG. 2 shows a side-view of one of the blind-mate connector assemblies of FIG. 1. Reference number 100 may be
15 regarded as typical of the signal processing boards 12, 14, 16, 18 of FIG. 1. Reference number 102 may be regarded as typical of connector modules 48, 50, 52, 54, 56, 58, 60, 62 and reference number 104 may be typically of a portion of the stationary blind-mate connectors 20,
20 22, 24, 26. Reference number 122 may be regarded as typical of the multi-mode fibers 30, 32, 34, 36, 37, 38, 40, 42, 44 of the backplane 28. Reference number 120 may be regarded as typical of a multi-mode fiber corresponding to a particular input/output of one of the
25 signal processing boards 12, 14, 16, 18.

To achieve alignment of the connected multi-mode fibers 120, 122, an equipment assembler (not shown) first inserts a signal processing card (e.g., 12) into a card slot 64, 66. The card slot serves as a first
30 mechanism of alignment. As the card 12 nears a "seated" position, a set of guide pins 112, 114 engage a set of tapered holes 116, 118. The tapered holes 116, 118 urges a male member 120 of the multi-mode fiber into alignment with a female receptacle 116, which is also

tapered. As the signal processing board 12, 14, 16, 18 reaches the seated position the taper of the female receptacle of the multi-mode fiber 122 urges the male fiber 120 into a final alignment relationship.

5 To facilitate alignment between the guides 64, 66 of the signal processing card 12, 14, 16, 18 and blind-mate connectors 102, 104, a set of free-floating pins 124, 126 may be provided. Further, the pins 124, 126 may be provided with slotted holes 128, 130 to further
10 allow the blind-mate module 102 to properly align with the stationary blind-mate connector 104.

To couple the communication system 10 to each of the signal processing cards, one or more laser transmitters (e.g., 850nm VCSEL devices) in the form of
15 a VCSELL array 106 may be provided within some or all of the blind-mate modules 48, 50, 52, 54, 56, 58, 60, 62. Similarly, one or more photonics detectors (e.g., PIN diodes) in the form of a detector array 108 may be provided within some or all of the blind-mate modules
20 48, 50, 52, 54, 56, 58, 60, 62. The laser transmitter 106 and detector 108 together form a transceiver that may be coupled to the signal processing card 12, 14, 16, 18 through an interface 110.

The interface 110 may simply be an electrical
25 connector where the signal processing boards operate completely under an electric format. Alternatively, where the signal processing boards have optical transceivers, the interface 110 may be a set of optical jumper fibers connecting the blind-mate module 102 to
30 the signal processing card 100.

Under the illustrated embodiment, the optical communication system 10 may provide signal processing cards 12, 14, 16, 18 with optical outputs from other signal processing cards 12, 14, 16, 18. Alternatively,

an optical output (e.g., 30) may be routed to an optical switch 46. A switch controller 68 may be used to activate the switch 46, thereby routing optical outputs where necessary for the functioning of the overall system.

FIG. 3 shows the optical routing capabilities of the backplane 28 in more detail. Under the illustrated embodiment of FIG. 3, an output of any signal processing board 12, 14, 16, 18 may be provided as an input to any other signal processing board 12, 14, 16, 18. For purposes of explanation, blind-mate modules 48, 52, 56, 60 have been assumed to be VCSEL arrays providing one or more outputs. Blind-mate modules 50, 54, 58, 62 have been assumed to be detector arrays providing at least four inputs each.

As shown an output of the blind-mate module 48 of first signal processing board 12 is provided as an input to a splitter 150. Any appropriate splitter may be used (e.g., a Gould Fiber Optics Multi-Mode Splitter).

An output of the first splitter 150 may be provided as an input to an optical switch 158. Any appropriate optical switch may be used (e.g., a Litton Electromechanical Multi-Mode Switch).

An output of the optical switch 158 is routed to an input 54, 58 of each of two other signal processing cards 14, 16. The switch 158 under control of switch control 68 may supply the output of the first signal processing board 12 as inputs to either of the other two signal processing boards 14, 16.

Similarly, a second output of the first splitter 150 may be provided as an input to a second switch 166. The switch 166 under control of switch control 68 may supply the output of the first signal processing board

12 as inputs to either the either the fourth signal processing board 18 or to another cabinet 174.

In a similar manner, an output of the second signal processing board 14 is provided as an input to a second
5 splitter 152. Outputs of the second signal processing board 14 may be provided as inputs to the first, third or fourth signal processing boards 12, 16, 18 through switches 152, 165. Similar provisions are made for the outputs of the third and fourth signal processing boards
10 16, 18.

Under another illustrated embodiment (FIG. 4), blind-mate modules 48, 52, 56, 60 include 4-output VCSEL arrays. A first output is provided through a first switch 200 to an input 54 of the second signal
15 processing board 14. A second output is provided through a second switch 202 to an input 58 of the third signal processing board 16. A third output is provided through a first switch 204 to an input 62 of the fourth signal processing board 14. A fourth output is provided
20 as an input to another cabinet 172.

Similarly, an output 52 of the second signal processing board 14 provides an input 50, 58, 62 to the first, third and fourth signal processing boards 12, 16, 18. The outputs 56, 60 of the third and fourth signal
25 processing boards 16, 18 as similarly provided as inputs to the other boards.

Control of the switches 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222 is provided from switch control 68. The proper entry of switch control
30 parameters into switch control 68 allows any output of any signal processing boards 12, 14, 16, 18 to be distributed to any one or more of the other signal processing boards or to other cabinets.

Under another illustrated embodiment (FIG. 5), the communication system 10 may be provided for operation under a wavelength division multiplexing (WDM) format. Under the illustrated embodiment, VSCEL laser arrays within the blind-mate connector modules 48, 52, 56, 60 are operated at a number of different wavelengths (e.g., 820nm 835nm, 850nm, 865nm, available from Honeywell Corporation). A combiner 258 may be used to combine the modulated information signal from each module 48, 52, 56, 60. Wavelength selective filters (e.g., Bragg filters) 250, 252, 254, 256 may be used to select specific wavelengths that are to be delivered to a particular signal processing board 12, 14, 16, 18.

Under the illustrated embodiment, a number of independent signal processing boards 12, 14, 16, 18 may be integrated using the communication system 10 of FIG. 1. Such a system 10 allows any combination of signal processing boards 12, 14, 16, 18 to be integrated into complex systems with capabilities far beyond the capabilities of any one of the individual signal processing boards. Further, the optical nature of the communication system 10 allows for the transport of information signals at a speed at least comparable to the speed of any one signal processing board.

A specific embodiment of a method and apparatus of providing a communication system among signal processing boards according to the present invention has been described for the purpose of illustrating the manner in which the invention is made and used. It should be understood that the implementation of other variations and modifications of the invention and its various aspects will be apparent to one skilled in the art, and that the invention is not limited by the specific embodiments described. Therefore, it is contemplated to

cover the present invention any and all modifications, variations, or equivalents that fall within the true spirit and scope of the basic underlying principles disclosed and claimed herein.

Claims

1. A method of transporting a plurality of information signals among a plurality of signal processing boards all located within a single cabinet of an information processing system; such method comprising the steps of:
- 5 connecting a plurality of multi-mode fibers among the plurality of signal processing boards;
- electrooptically converting an information signal of the plurality of transported information signals
- 10 between an electrical format used on a corresponding pair of signal processing boards of the plurality of signal processing boards and an optical format used for transmission through a corresponding multi-mode fiber of the plurality of multi-mode fibers; and
- 15 optically switching a transported information signal of the transported information signals between a set of multi-mode fibers of the plurality of multi-mode fibers.
- 20 2. The method of transporting information signals as in claim 1 wherein the step of electro-optically converting the information signal further comprises providing a VCSEL laser transmitter array for each signal processing board of the plurality of signal processing boards for conversion from the electrical
- 25 format of the signal processing board to the optical format of the multi-mode fibers.
3. The method of transporting information signals as in claim 2 further comprising coupling a corresponding multi-mode fiber of the plurality of multi-mode fibers
- 30 to each VCSEL laser transmitter of the VCSEL laser transmitter array.

4. The method of transporting information signals as in claim 3 further comprising providing a PIN diode array for each signal processing board for conversion from the optical format of the plurality of multi-mode
5 fibers to the electrical format of the signal processing board.

5. The method of transporting information signals as in claim 4 further comprising coupling a corresponding
10 multi-mode fiber of the plurality of multi-mode fibers to each PIN diode of the PIN diode array.

6. The method of transporting information signals as in claim 5 further comprising interposing a signal
15 splitter into a multi-mode fiber of the plurality of multi-mode fibers between a VCSEL laser transmitter of a signal processing board and a pair of multi-mode fibers connected to at least two other signal processing boards of the plurality of signal processing boards.

20 7. The method of transporting information signals as in claim 5 wherein the step of optically switching a transported information signal further comprises interposing a optical switch into a multi-mode fiber of
25 the plurality of multi-mode fibers between a VCSEL laser transmitter of a signal processing board and a pair of multi-mode fibers connected to at least two other signal processing boards of the plurality of signal processing boards.

30 8. The method of transporting information signals as in claim 7 further comprising dynamically redirecting an transported information signal of the information

signals based upon a routing control signal from a routing signal controller.

9. The method of transporting information signals as in claim 8 further comprising asserting the routing control signal from a routing signal controller upon failure of one of the pair of multi-mode fibers connected to the at least two other signal processing boards of the plurality of signal processing boards.

10

10. The method of transporting information signals as in claim 1 further comprising wavelength division multiplexing at least some of the plurality of information signals onto a single multi-mode fiber of the plurality of multi-mode fibers.

11. The method of transporting information signals as in claim 1 further comprising slitting a transported information signal of the plurality of information signals and sending the split transported information signals directly to respective signal processing boards of the plurality of signal processing boards.

12. An apparatus for transporting a plurality of information signals among a plurality of signal processing boards all located within a single cabinet of an information processing system, such apparatus comprising:

means for connecting a plurality of multi-mode fibers among the plurality of signal processing boards;
means for electrooptically converting an information signal of the plurality of transported information signals between an electrical format used on a corresponding pair of signal processing boards of the

- plurality of signal processing boards and an optical format used for transmission through a corresponding multi-mode fiber of the plurality of multi-mode fibers; and
- 5 means for optically switching a transported information signal of the transported information signals between a set of multi-mode fibers of the plurality of multi-mode fibers.
- 10 13. The apparatus for transporting information signals as in claim 12 wherein the means for electro-optically converting the information signal further comprises means for providing a VCSEL laser transmitter array for each signal processing board of the plurality of signal
- 15 processing boards for conversion from the electrical format of the signal processing board to the optical format of the multi-mode fibers.
- 20 14. The apparatus for transporting information signals as in claim 13 further comprising means for coupling a corresponding multi-mode fiber of the plurality of multi-mode fibers to each VCSEL laser transmitter of the VCSEL laser transmitter array.
- 25 15. The apparatus for transporting information signals as in claim 14 further comprising means for providing a PIN diode array for each signal processing board for conversion from the optical format of the plurality of multi-mode fibers to the electrical format of the signal
- 30 processing board.
16. The apparatus for transporting information signals as in claim 15 further comprising means for coupling a corresponding multi-mode fiber of the plurality of

multi-mode fibers to each PIN diode of the PIN diode array.

17. The apparatus for transporting information signals
5 as in claim 16 further comprising means for interposing
a signal splitter into a multi-mode fiber of the
plurality of multi-mode fibers between a VCSEL laser
transmitter of a signal processing board and a pair of
multi-mode fibers connected to at least two other signal
10 processing boards of the plurality of signal processing
boards.

18. The apparatus for transporting information signals
as in claim 16 wherein the means for optically switching
15 a transported information signal further comprises means
for interposing a optical switch into a multi-mode fiber
of the plurality of multi-mode fibers between a VCSEL
laser transmitter of a signal processing board and a
pair of multi-mode fibers connected to at least two
20 other signal processing boards of the plurality of
signal processing boards.

19. The apparatus for transporting information signals
as in claim 18 further comprising means for dynamically
25 redirecting an transported information signal of the
information signals based upon a routing control signal
from a routing signal controller.

20. The apparatus for transporting information signals
30 as in claim 18 further comprising means for asserting
the routing control signal from a routing signal
controller upon failure of one of the pair of multi-mode
fibers connected to the at least two other signal

processing boards of the plurality of signal processing boards.

21. An apparatus for transporting a plurality of
5 information signals among a plurality of signal processing boards all located within a single cabinet of an information processing system, such apparatus comprising:

10 a plurality of multi-mode fibers adapted for providing a plurality of optical signal paths among the plurality of signal processing boards;

an electrooptic converter adapted to convert an information signal of the plurality of transported information signals between an electrical format used on
15 a corresponding pair of signal processing boards of the plurality of signal processing boards and an optical format used for transmission through a corresponding multi-mode fiber of the plurality of multi-mode fibers;
and

20 an optical switch adapted to transport an information signal of the transported information signals between a set of multi-mode fibers of the plurality of multi-mode fibers.

- 25 22. The apparatus for transporting information signals as in claim 21 wherein the electrooptical switch further comprises a VCSEL laser transmitter array disposed on each signal processing board of the plurality of signal processing boards for conversion from the electrical
30 format of the signal processing board to the optical format of the multi-mode fibers.

23. The apparatus for transporting information signals as in claim 22 further comprising a blind-mate connected

adapted to couple a corresponding multi-mode fiber of the plurality of multi-mode fibers to each VCSEL laser transmitter of the VCSEL laser transmitter array.

5 24. The apparatus for transporting information signals as in claim 23 further comprising a PIN diode array disposed on each signal processing board for conversion from the optical format of the plurality of multi-mode fibers to the electrical format of the signal processing
10 board.

25. The apparatus for transporting information signals as in claim 24 further comprising a blind-mate connector adapted to couple a corresponding multi-mode fiber of
15 the plurality of multi-mode fibers to each PIN diode of the PIN diode array.

26. The apparatus for transporting information signals as in claim 25 further comprising a signal splitter
20 interposed into a multi-mode fiber of the plurality of multi-mode fibers between a VCSEL laser transmitter of a signal processing board and a pair of multi-mode fibers connected to at least two other signal processing boards of the plurality of signal processing boards.

25 27. The apparatus for transporting information signals as in claim 25 wherein the optical switch further comprises a multi-mode fiber of the plurality of multi-mode fibers interposed between a VCSEL laser transmitter
30 of a signal processing board and the optical switch and a pair of multi-mode fibers interposed between the optical switch and at least two other signal processing boards of the plurality of signal processing boards.

28. The apparatus for transporting information signals
as in claim 27 further comprising a routing signal
controller adapted to dynamically redirect an
transported information signal of the information
5 signals.

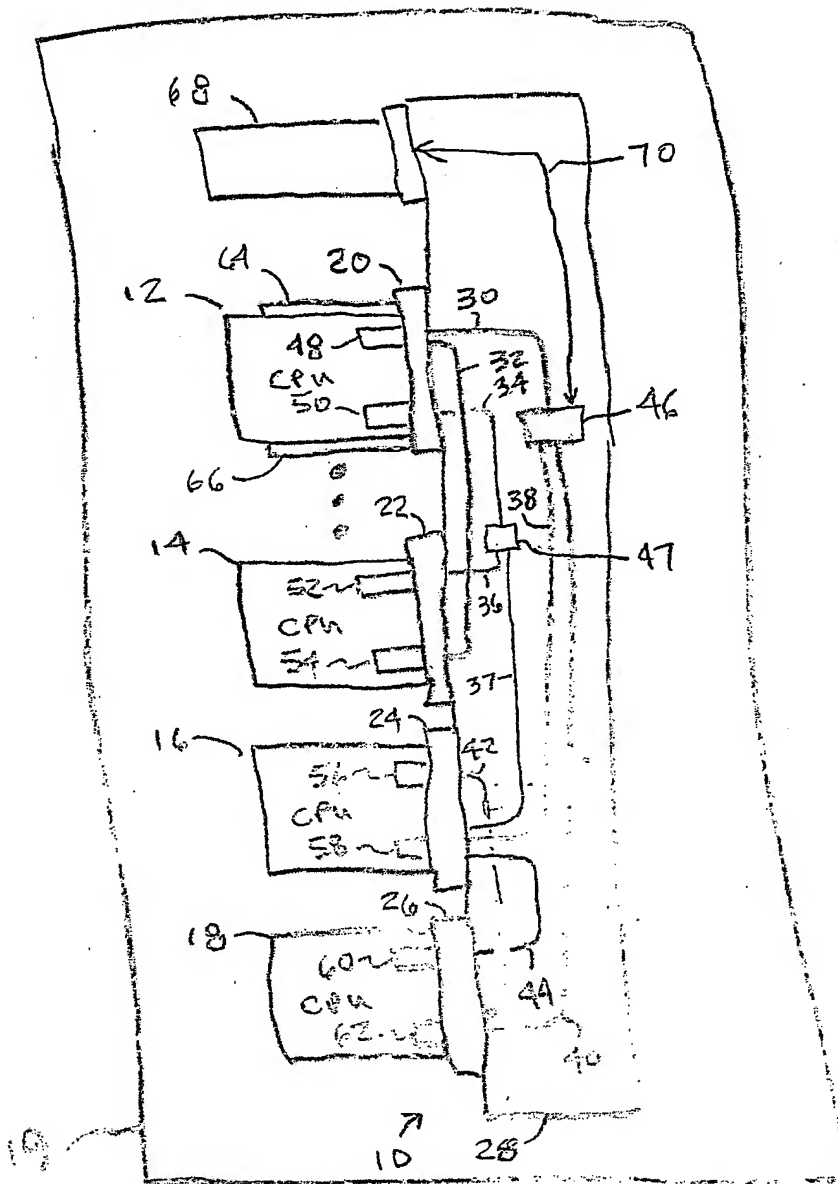


FIG. 1

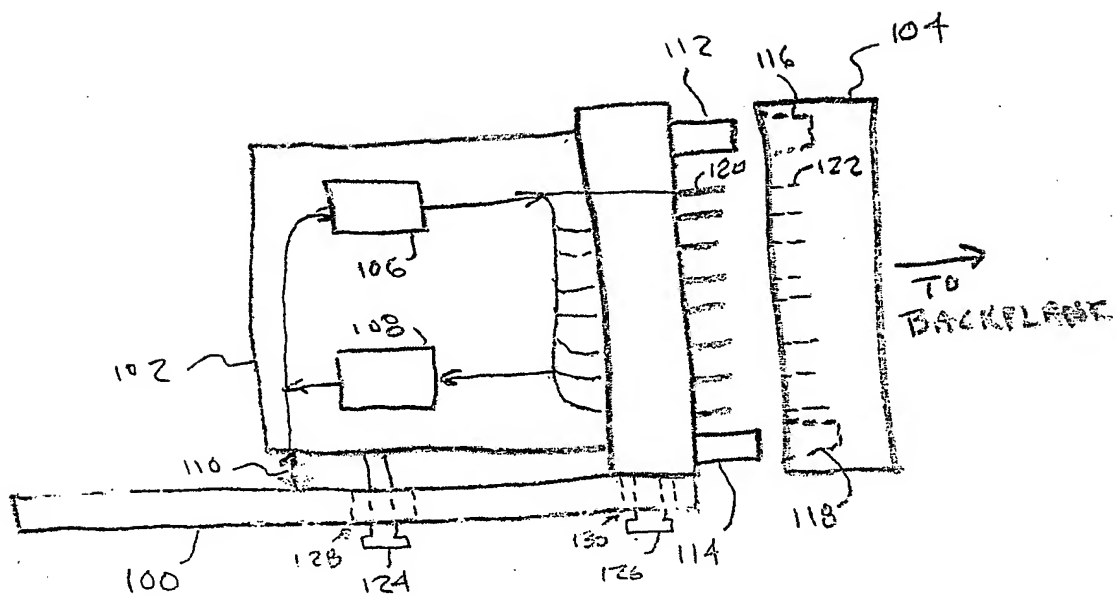
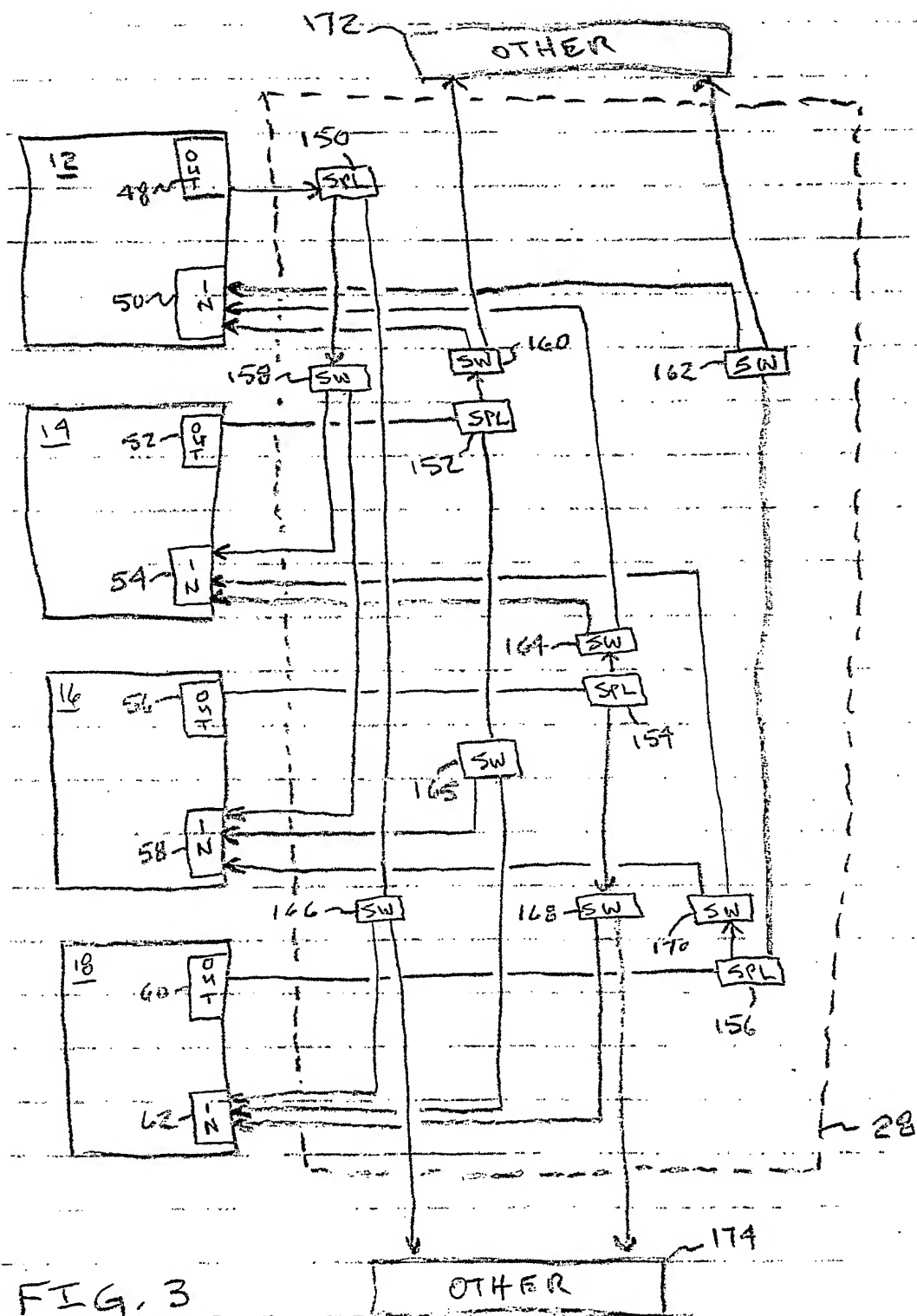


FIG. 2



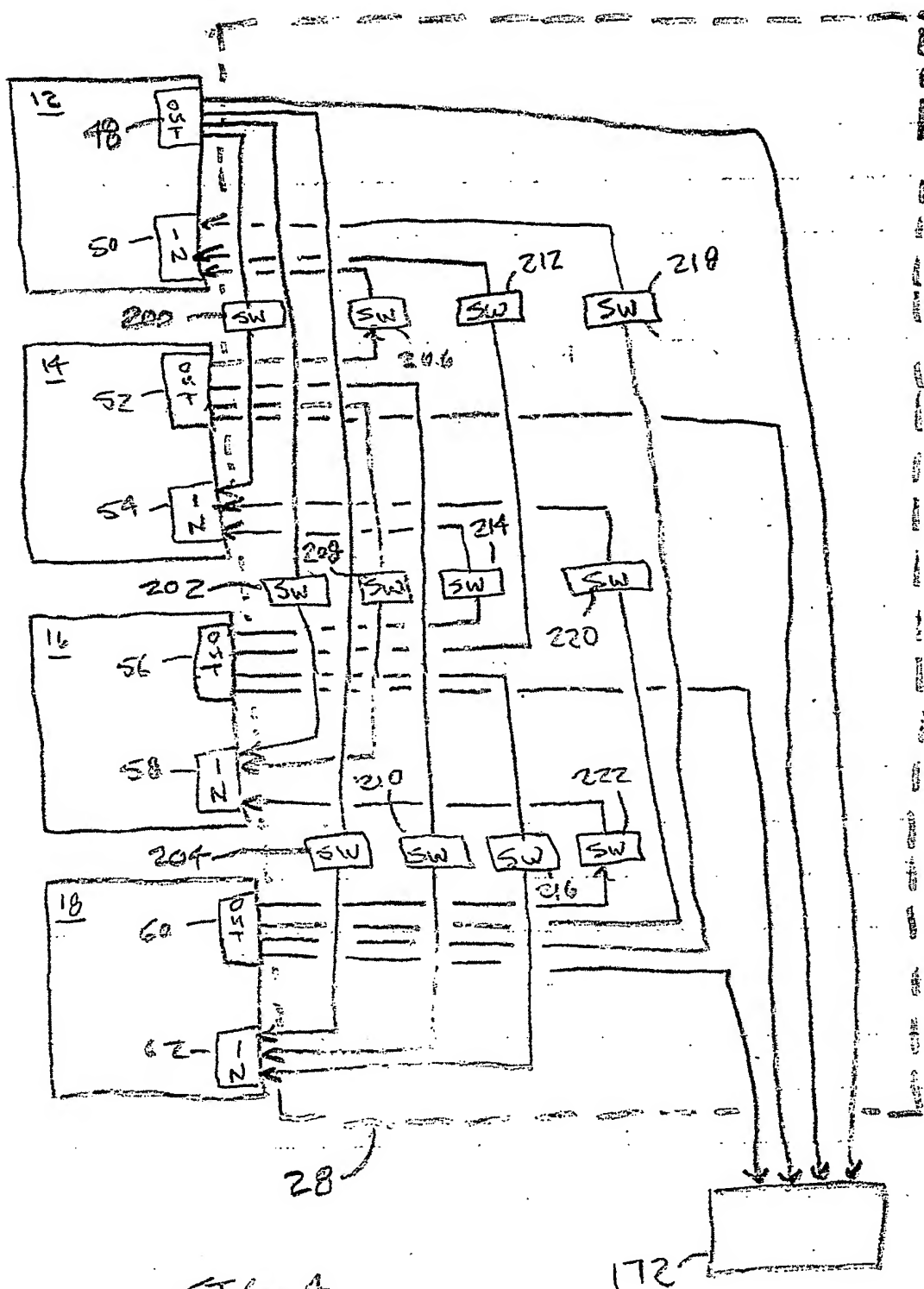
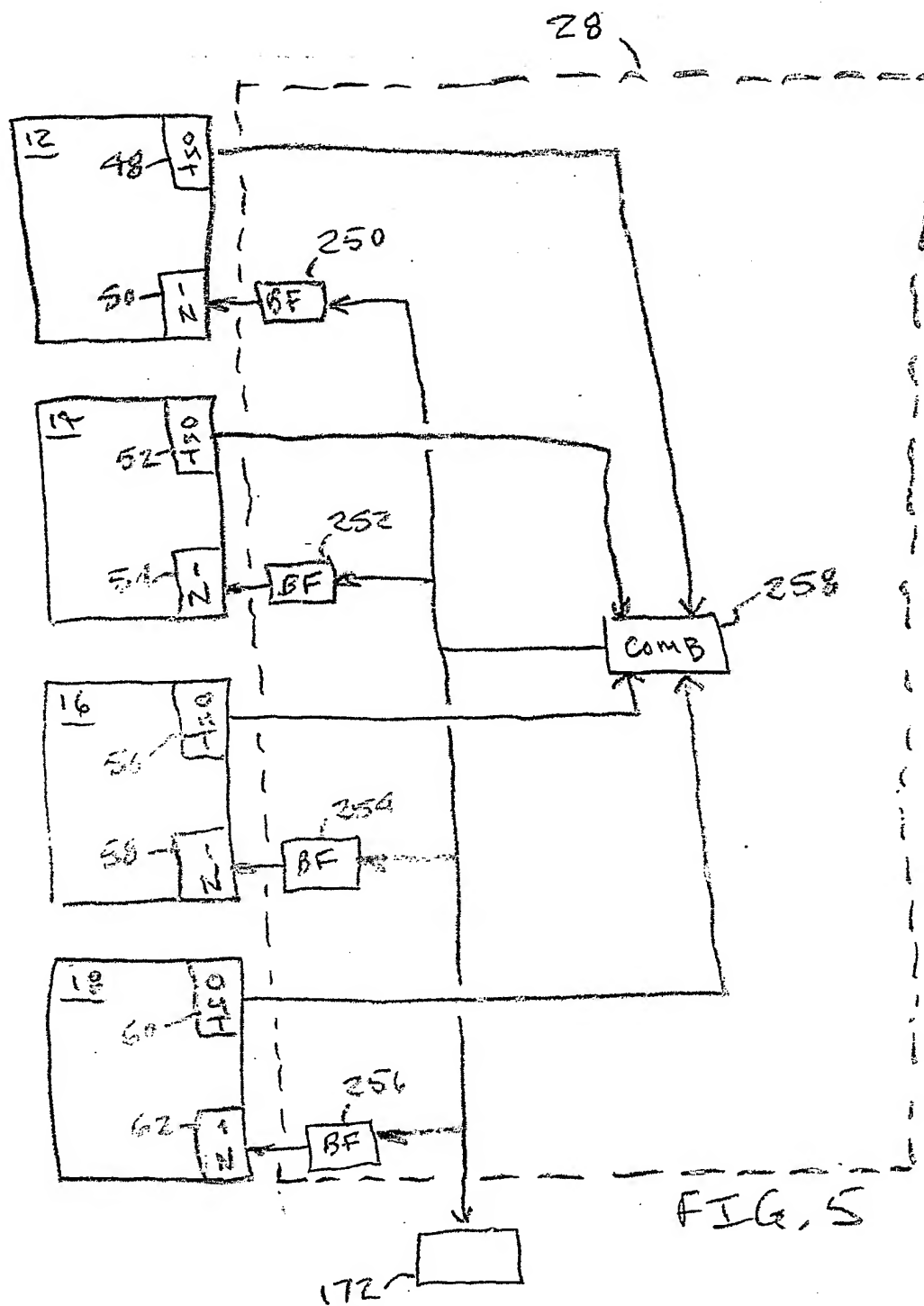


FIG. 4



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 385/53, 88-93

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, E	US 6,226,296 A (LINDSEY et al.) 01 May 2001 (01.05.2001), see entire document.	1-28
A	US 5,067,787 A (GILLHAM et al.) 26 November 1991 (26.11.1991), see entire document.	1-28

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Continuation of B. **FIELDS SEARCHED** Item 3: East search terms: multi-mode optical fibers, electrooptical converter, optical switch